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Stratigraphy of the East Flank of the Green Mountain Anticlinorium, Southern Vermont

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Trip B-1

STRATIGRAPHY OF THE EAST FLANK OF THE GREEN MOUNTAIN ANTICLINORIUM, SOUTHERN VERMONT

by

James W. Skehan, S.J.* and J. Christopher Hepburn*

INTRODUCTION

The Green Mountain anticlinorium in southern Vermont has an exposed core of Precambrian gneisses overlain to the east and west by metamorphosed Paleozoic rocks. The rocks of the west limb of the anticlinorium are chiefly quartzites and carbonates of a miogeosynclinal sequence. The east limb of the anticlinorium consists of a eugeosynclinal sequence of schists and gneisses from (?)Cambrian through Lower Devonian age. The purpose of the present field trip is to examine the stratigraphy of these schists and gneisses. A roughly west-to-east section across portions of the Wilmington and Brattleboro quadrangles (Fig. 1) will be followed.

The earliest geological mapping in the area was done by E. Hitchcock and others during the compilation of the Geology of Vermont (E. Hitchcock et al., 1861). Hubbard (1924), Prindle and Knopf (1932), Richardson (1933), and Richardson and Maynard (1939) studied portions of the area. Thompson (1950) and Rosenfeld (1954), working in the Ludlow and Saxtons River quadrangles respectively, started the comprehensive detailed mapping of southern Vermont. Detailed geological mapping of the field trip area has been compiled by the authors (Fig. 1). The Wilmington-Woodford area was mapped by Skehan (1953, 1961), and the Brattleboro area by Hepburn (1972b).

Most of the stratigraphic units of the east limb of the Green Mountain anticlinorium in southern Vermont can be traced directly from the Wilmington-Brattleboro area to their type localities further north in Vermont or to the south in Massachusetts. A few can be traced into fossiliferous strata. Currently a number of workers (see for example Hatch, Osberg, and Norton, 1967; Hatch, 1967; Hatch, Schnabel and Norton, 1968) are tracing many of these units and their correlatives southward through western Massachusetts and western Connecticut.

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STRATIGRAPHY

The stratigraphy of the field trip area is briefly summarized below. See Skehan (1961) and Hepburn (1972b) for more complete descriptions.

Wilmington Gneiss

The Wilmington Gneiss named by Skehan (1961) is of uncertain stratigraphic position. It may be Precambrian in age, resembling as it does the microcline gneiss sequence of the Mt. Holly Complex of the Green Mountain core. On the other hand the apparently conformable relationship immediately beneath the Hoosac and Tyson Formations along their eastern contact (Fig. 1) suggests strongly the possibility that the Wilmington Gneiss may be of Cambrian age. The complex and unexplained relationships of the Wilmington Gneiss to the members of the Cavendish Formation of Doll et al. (1961) along the western contact make a decision as to the age of the Wilmington Gneiss impossible at this time.

The Wilmington Gneiss consists of a medium to very coarse-grained, well-banded, somewhat foliated biotite-epidote-quartz-microcline augen gneiss. The microcline is gray to pink and occurs as lenticular augen and flaser in which the average long diameter is about 7mm. Locally the augen may reach 8 in. in length and are usually flattened into the plane of the foliation. Quartz rods and linearly aligned streaks of biotite are a common feature of the Wilmington Gneiss.

The Wilmington Gneiss may be the correlative of the Bull Hill Gneiss of Doll et al. (1961), an exposure of which is only one mile north of and on line with the northernmost exposure of the Wilmington Gneiss of the Wilmington quadrangle (Skehan, 1961, Pl. I).

Tyson Formation

The Tyson Formation, named by Thompson (1950), is recognized in this area only as discontinuous lenses of fine to coarse-grained, schistose, white to blue quartz-pebble conglomerate; fine to coarse-grained gray, buff and pink microcline-pebble and coarse-grained albite-pebble conglomerate and conglomeratic schist; and thin-bedded quartzite and dark biotite-muscovite-quartz schist.

Hoosac Formation

The Hoosac Formation (Hoosac Schist of Pumpelly et al., 1894) consists of gray, brown and black, medium to coarse-grained muscovite-biotite-albite-quartz schists locally containing variable amounts of chlorite, muscovite, paragonite and garnet. Rocks containing appreciable garnet commonly weather to a mottled rusty color. Albite megacrysts 2-15 mm. in diameter are characteristic of the formation, which is distinguished from the overlying Pinney Hollow Formation by the presence of more abundant albite megacrysts, its color, and its generally coarser and more granular texture.

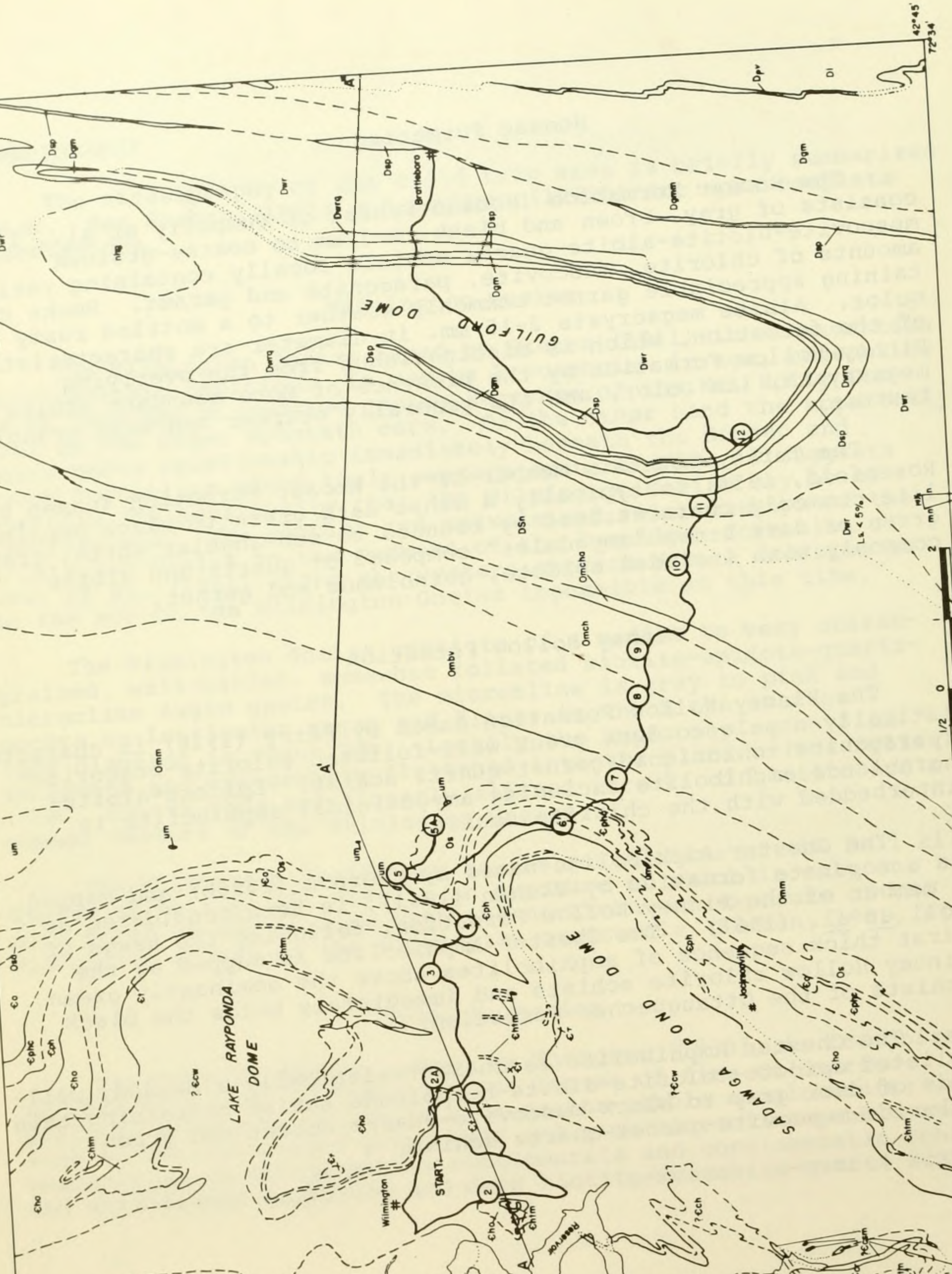
The Turkey Mountain Member of the Hoosac Formation (named by Rosenfeld, 1954) is typically a dense dark green to black amphibolite commonly characterized by rounded to sub-angular white, gray, green or dark brown "amygdules" composed of quartz and albite commonly with included epidote, hornblende and garnet.

Pinney Hollow Formation

The Pinney Hollow Formation named by Perry (1928) is characteristically a pale to dark green well-foliated chlorite-muscovite-(paragonite)-chloritoid-garnet-quartz schist. Epidote-albite-hornblende amphibolite including amygdaloidal amphibolite is interbedded with the chlorite schist.

The Chester Amphibolite named by Emerson (1898b) and mapped as a separate formation by Skehan (1961), is here considered as a member of the Pinney Hollow Formation, following the usage of Doll et al. (1961). The Chester Amphibolite is mapped as the first thick sequence of amphibolites above the dominantly green Pinney Hollow chlorite schists and immediately below the black schists of the Ottauquechee Formation.

The Chester Amphibolite is characteristically a banded, well-foliated epidote-chlorite-albite-hornblende schist containing thin beds of dark gray to black muscovite-quartz schist and green chlorite-muscovite-garnet-quartz schist.


LAKE RAYPONDA DOME
SADAWGA DOME
GUILFORD DOME
Brattleboro
Wilmington
Jacksonville
Harriman
Reservoir
START
72°34'
42°57'
72°55'
42°45'

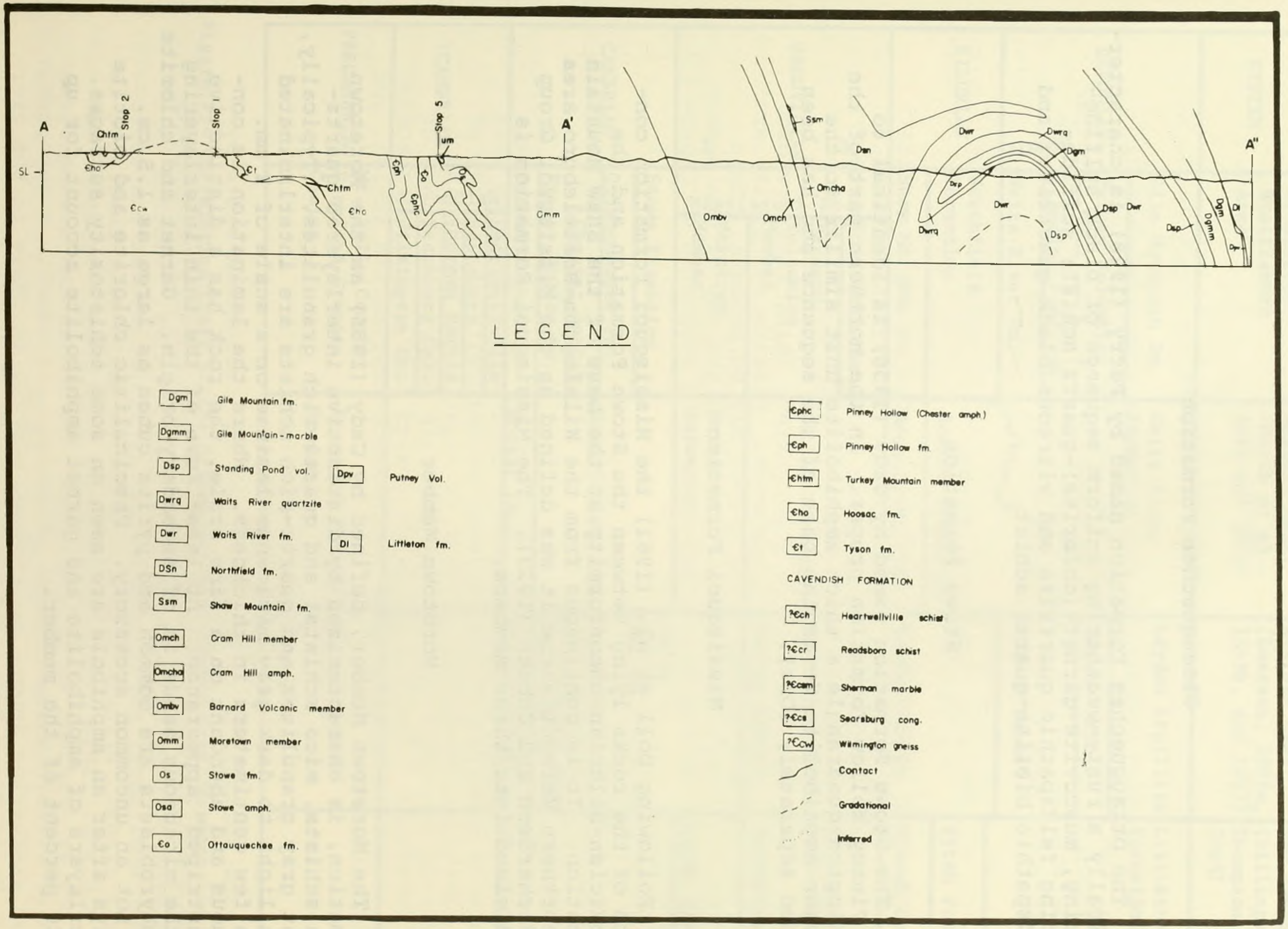


FIGURE I

GEOLOGIC MAP OF THE WILMINGTON-BRATTLEBORO AREA

Ottauquechee Formation

The Ottauquechee Formation named by Perry (1928) is characteristically a rusty-weathering uniform sequence of black sulfide-bearing, muscovite-garnet-(chlorite)-quartz schist; sulfide-bearing feldspathic quartzite and vitreous black quartzite; and feldspathic biotite-quartz schist.

Stowe Formation

The Stowe Formation named by Cady (1956) is identical to the Pinney Hollow Formation proper. In the northern part of the Wilmington quadrangle a thick amphibolite unit similar to the Chester Amphibolite forms the base of the sequence and has been mapped separately (Osa).

Missisquoi Formation

Following Doll *et al*. (1961) the Missisquoi Formation consists of the rocks lying between the Stowe Formation and the Ordovician-Silurian unconformity at the base of the Shaw Mountain Formation. It is continuous from the Wilmington-Brattleboro area to northern Vermont where it was defined as the Missisquoi Group by Richardson and Cabeen (1923). The Missisquoi Formation is subdivided into three members.

Moretown Member

The Moretown Member, defined by Cady (1956) as the Moretown Formation, is characterized by distinctive interlayered quartz-mica schists, mica schists, and quartz-rich granulites. Typically, light gray granulites and quartz-rich schists are interlaminated with light to dark gray micaceous laminae on a scale of 2 mm. to a few centimeters in thickness. Where the lamination is continuous and abundant on a fine scale, the rock has a distinctive "pinstriped" appearance. At least some of the thin interlayering of the micaceous bands is of secondary origin. Garnet and chlorite porphyroblasts are common and pyrite cubes as large as 1.5 cm. are not an uncommon accessory. Fasciculitic chlorite and biotite sprays after an amphibole are seen on some schistosity surfaces. Interlayers of amphibolite and garnet amphibolite account for up to 20 percent of the member.

SYSTEM		Wilmington-Brattleboro Area	Western Mass. (Hatch *et al.*, 1968 and 1970)	Western Mass. (Emerson, 1898a, 1898b, and 1917)	New Hampshire (Billings, 1956; Thompson *et al.*, 1968)
DEVONIAN	LOWER	Gile Mountain Fm.	Waits River Formation	Leyden Argillite	Littleton Formation; Erving Member
		Putney Volcanics		Conway Amphib.	
		? ? ?			
		Standing Pond Vol.			
		Waits River Fm.		Conway Schist	
SILURIAN		Northfield Formation	Goshen Formation		Fitch Formation
		Shaw Mt. Fm.	Russell Mt. Fm.	Goshen Schist	Clough Quartzite
ORDOVICIAN	M; Missisquoi Fm.	Cram Hill Mbr.	Hawley Formation		Partridge Fm.
		Barnard Volcanics Member		Hawley Schist	Ammonoosuc Vol.
	L; Missisquoi Fm.	Moretown Member	Moretown Formation		Albee Formation
CAMBRIAN		Stowe Formation	Rowe Schist	Savoy Schist	
		Ottauquechee Fm.			
		Chester Amphib.		Chester Amphib.	
		Pinney Hollow Fm.		Rowe Schist	
		Hoosac Formation	Hoosac Fm.	Hoosac Schist	
?CAMBRIAN	Cavendish Fm.	Heartwellville			
		Readsboro			
		Sherman Marble			
		Searsburg Cgl.			
		Wilmington Gn.			
PRECAMBRIAN		Mt. Holly Complex Stamford Granite Gneiss	Stamford Granite Gneiss	Becket Gneiss	

Figure 2. Correlation Chart of the Wilmington-Brattleboro Area, Vermont.

Barnard Volcanic Member

The Barnard Volcanic Member includes a wide variety of rocks, but three general types are most abundant: non-porphyritic amphibolite; porphyritic amphibolite with numerous feldspar megacrysts; and light-colored, felsic schist and gneiss. The felsic rocks make up 35 to 50 percent of the member.

Cram Hill Member

The Cram Hill Member, first designated as the Cram Hill Formation by Currier and Jahns (1941), is correlative with fossiliferous late Middle Ordovician rocks at Magog, Quebec (Berry, 1962). The member consists largely of fine-grained black phyllite and schist that weathers a rusty-brown from finely disseminated pyrite or pyrrhotite. Thin, fine-grained, black quartzite beds are not uncommon. Biotite and pyrite are the common porphyroblasts, and garnet may be present. Thin amphibolite layers are common. A zone at the top of the member in which amphibolite predominates has been separated on Figure 1 as Omcha.

Shaw Mountain Formation

In the Brattleboro quadrangle the Silurian Shaw Mountain Formation (Currier and Jahns, 1941) occurs in only three thin lenses to the east of the regional unconformity at the top of the Missisquoi Formation. White to light brown weathering quartzite and quartz-pebble conglomerate occur at the base of the formation. These rocks grade upward into quartz-mica schist, mica schist, a coarse-grained hornblende fasciculite schist, and amphibolite.

Northfield Formation

The Northfield Formation, named the Northfield Slate by Currier and Jahns (1941), is a uniform sequence of gray to dark gray, graphitic quartz-muscovite schists with very conspicuous almandine porphyroblasts 1 to 2 mm. in diameter. Biotite is a common additional porphyroblast, as is staurolite at the appropriate grade. Crinkle lineations are commonly well developed in the schists. Thin quartzite beds are occasionally present but are not as abundant as they are along strike in the Goshen Formation of western Massachusetts (Hatch et al., 1968). A few punky-brown weathering impure marble beds similar to those in the overlying Waits River Formation are present.

Waits River Formation

The Waits River Formation (Currier and Jahns, 1941) consists of interbeds of three broad categories of rocks: impure marbles, various schists, and impure quartzites. The most distinctive rocks are the impure marbles, which weather to a punky-brown and have a friable surficial rind of non-calcareous minerals, largely quartz, left behind where the carbonate has weathered out. The impure marbles occur in beds a few inches to tens of feet thick. The percentage of these beds varies throughout the formation.

The schistose rocks are quite variable but generally weather dark gray to brown and contain quartz and muscovite with differing amounts of biotite, garnet, or carbonate. Zoisite may be an additional porphyroblast.

Thin beds of light gray feldspathic and micaceous quartzite occur throughout the formation. A narrow band adjacent to the Standing Pond Volcanics has been separated (Dwrq, Fig. 1) in which the impure quartzites are present to the exclusion of the other rocks.

Standing Pond Volcanics

The Standing Pond Volcanics (Doll, 1944, Standing Pond Amphibolite) consist mostly of black, massive to moderately foliated amphibolite and epidote amphibolite. Very coarse-grained garnet amphibolite is commonly present near the contact with the Waits River Formation. Minor amounts of brown-weathering schist, feldspathic quartzite and coticule are also present. The eastern band of the Standing Pond Volcanics (Fig. 1) is composed of plagioclase-biotite-quartz and plagioclase-biotite-hornblende-quartz granulite.

Gile Mountain Formation

In the area to be visited by this field trip the Gile Mountain Formation (Doll, 1944, Gile Mountain Schists) is metamorphosed to the kyanite-staurolite zone. At this grade of metamorphism the principal rocks in the Gile Mountain Formation are micaceous and feldspathic quartzites and mica schists. The quartzites weather light gray and contain variable amounts of quartz, feldspar, muscovite, and biotite. Garnet, hornblende, and ankerite are present in minor amounts. Kyanite, staurolite, and garnet porphyroblasts are common in the mica schist interbeds.

STRUCTURE

The axial trace of the regional Green Mountain anticlinorium (Skehan, this volume, Sunday Trip, Figs. 1 and 3) lies just to the west of the field trip area. Most of the units seen on the field trip dip moderately to steeply east and are part of the homoclinal sequence of the east limb of the anticlinorium (Fig. 1). The Lower Cambrian miogeosynclinal facies, well-developed on the western limb of the anticlinorium, can be traced to its southeast limb, where it appears to be cut off by the Hoosac thrust fault. The (?)Cambrian Cavendish Formation in the southern part of the area overlies these Lower Cambrian rocks and the Precambrian core as a result of westward thrusting. In the northern part of the area, the Cavendish may be separated from the Precambrian by an angular unconformity or by the continuation of the Hoosac thrust. Overlying the Cavendish Formation is the Cambrian and Ordovician sequence of metasediments and metavolcanics. The Lake Rayponda and Sadawga Pond domes (Fig. 1) have locally disrupted the eastern limb of the anticlinorium.

The Guilford dome lying east of the Green Mountain anticlinorium is part of a belt of domes that stretches from central Vermont to Connecticut, west of the Connecticut River. The Chester and Athens domes, just north of the field trip area, have exposed Precambrian rocks in their cores. The Siluro-Devonian Waits River Formation is exposed in the center of the Guilford dome. Large recumbent folds are present in the strata mantling these domes in eastern Vermont. The doubly-closed loop of the Standing Pond Volcanics (Fig. 1) outlines such a fold, the Prospect Hill recumbent fold. This recumbent fold had formed prior to the doming and had a NE-SW trending axis. The subsequent doming arched the axial surface of the recumbent fold, causing the hinges to plunge moderately NE and SW away from the roughly N-S axial trace of the dome.

A sequence of at least four minor fold stages (Hepburn, 1972a) has been worked out for the eastern portion of the field trip area. The following sequence of minor folds is inferred:

(1) Small isoclinal folds with a schistosity developed parallel to their axial surfaces.

(2) Tight to isoclinal folds related to the Prospect Hill recumbent fold. A schistosity is developed parallel to the axial surfaces of these folds in some of the metapelites.

(3) Open folds with a slip-cleavage developed parallel to their axial surfaces. This cleavage generally strikes northeast and dips moderately to steeply northwest. These folds may have formed during the development of the Guilford dome.

(4) One or more generations of open folds, warps, or buckles in the foliation that fold the slip-cleavage.

Metamorphism

The area was regionally metamorphosed during the Acadian Orogeny. At this time the Precambrian rocks in the exposed core of the Green Mountain anticlinorium, previously metamorphosed to a high degree during the Grenville Orogeny, were extensively retrograded. The rest of the field trip area was metamorphosed to the garnet zone, except for the Guilford dome where the staurolite-kyanite zone was reached, as seen at the last two stops.

Road Log for Trip
Friday, October 13, 1972

James W. Skehan, S.J. and J. Christopher Hepburn, Leaders

Primary references for this trip are:

Doll, et al., (1961) Centennial Geologic Map of Vermont, October, 1961 ($4.00).

Hepburn, J.C. (1972b) Geology of the Metamorphosed Paleozoic Rocks in the Brattleboro Area, Vermont, unpub. Ph.D. Thesis, Harvard University, 377 p.

Skehan, J.W., S.J. (1961) Geologic Map of the Wilmington-Woodford Area, from Bulletin 17, Vermont Geological Survey (25¢)

Skehan, J.W., S.J. (1961) The Green Mountain Anticlinorium in the Vicinity of Wilmington and Woodford, Vermont, Bulletin 17, Vermont Geological Survey, 159 p. ($3.00)

All references, except Hepburn (1972b) may be obtained from the State of Vermont, Department of Libraries, Montpelier, Vermont. Enclose payment with order.

Mileage

0.00 Assemble at the junction of Routes 9 and 100, 1.15 miles east of the center of Wilmington, Vermont in the parking lot of Coombs' Beaver Brook Sugar House (Fig. 1). Park south of the store out of traffic. West of Route 100 at this locality, large outcrops of Wilmington Gneiss can be seen and may be examined by those arriving early.

Departure time at 8:45 a.m. SHARP. Proceed to Stop 1 by going south on Route 100.

0.85 Turn left and proceed up the hill to Hubbard Hill Farm.

1.35 Stop 1. WILMINGTON GNEISS, TYSON AND HOOSAC FORMATIONS.

Park off the unpaved road near the farm buildings of Hubbard Hill Farm. To the northwest one may see the Wilmington Valley and the Haystack-Mount Snow Ridge. Proceed on foot uphill to the northeast toward the crest of the hill. The outcrops west of the hillcrest are those of the micaceous microcline augen Wilmington Gneiss. At this locality, between the well-developed Wilmington Gneiss and the typical micaceous albite schists of the

Mileage (cont'd)

Hoosac Formation, is a blue-quartz-bearing gneiss and schistose gneiss assigned to the Tyson Conglomerate (Skehan, 1961, pp. 65-66).

The structure is dominated by cascade folds in which the movement sense is such that the upper beds have moved easterly relative to the lower beds. Some outcrops on the eastern flank of this hill show well-developed cascade folds with amplitudes of 1 1/2 feet. Although a number of individual outcrops show shallow to steep westerly dips, the beds have an average dip to the east. The axial planes of the cascade folds dip at an average of 50° NW. Return to cars, turn around, and return 0.45 mile to Route 100.

1.75 Proceed south on Route 100.

1.77 Outcrops of rusty weathering, dark albite schist of the Hoosac Formation underlain by banded plagioclase gneiss of the Wilmington Gneiss on the east side of the highway.

1.95 Turn right off Route 100 south at the Dix School. Proceed southwest on Boyd Hill Road. This road crosses terrain underlain by the micaceous microcline augen gneisses of the Wilmington Gneiss Formation.

3.35 Stop 2. HOOSAC FORMATION, TURKEY MOUNTAIN MEMBER AND WILMINGTON GNEISS.

Park off the road wherever you can near two houses on the left and the barn on the right. Proceed to the hill by a path between the two houses. Climb up the hill examining the Wilmington Gneiss in the lower ledges. The albite schist sequence of the Hoosac Formation and the amphibolites of the Turkey Mountain Member of the Hoosac are exposed in the upper ledges and constitute an outlier of Cambrian rocks surrounded by Wilmington Gneiss. Return to the cars and proceed north.

3.60 On the west side of the road, outcrops of Wilmington Gneiss dip gently to the northwest at 15°. There is a strong quartz rodding and biotite lineation nearly down the dip.

Proceed north to the end of Boyd Hill Road.

5.20 Turn right and proceed to Wilmington Center (0.45 mile).

Mileage (cont'd)

5.65 At the lights in Wilmington Center, turn right (east) on Route 9.

6.35 On the hill to the north are rusty weathering, albite schists dipping gently to the north toward the center of the Wilmington syncline.

6.80 Coombs' Sugar House where the field trip began. Latecomers may join the trip at this time (approximately 10:15 a.m.) and place. Continue east on Route 9.

7.10 Turn left at the NAJEROG sign and proceed 0.4 mile along an unpaved road (the original Molly Stark Trail).

Stop 2a. TURKEY MOUNTAIN MEMBER

Park at a white house and barn belonging to Mr. and Mrs. Donald Koelsch. Go up the hill to the west, observing the Turkey Mountain Amphibolite Member and the overlying sequence of albite schists of the Hoosac Formation (Modes of the Hoosac Formation are in Tables 15-19, p. 68 Skehan, 1961). Proceed to the top of the hill where you may observe recumbent folds in the albite schist and the development of small-scale microcline pegmatites. Structural analysis indicates that the sense of movement of the upper beds is toward the east relative to the lower. Such folds have been described by Skehan (1961, p. 103) as cascade folds. They are commonly well displayed in association with the Sadawga Pond dome and to a lesser extent with the Lake Rayponda dome. Commonly throughout southern Vermont such minor folds are late structures and are selectively better developed on the eastern flanks of the domes. The fact that the cascade folds seem not to be equally well developed on all sides of the dome calls into question Skehan's (1961) and Thompson's (1950) earlier conclusion that these folds are a product of the doming. Such cascade folds as seen at Stop 1 may, however, be related antithetically in some as yet unexplained way to the development of nappe structures in the "upper decken."

Return to Route 9 and proceed east.

7.10 Albite schist of the Hoosac Formation on the left.

Mileage (cont'd)

7.60 Pass Shearer Hill Road on the right.

7.95 Thick-bedded albite schist (similar to those rocks referred to by Hitchcock *et al*., 1861, as the gneiss at Jacksonville).

8.45 Junction with road leading north to Lake Rayponda.

9.40 Stop 3. HOOSAC FORMATION

Park on the west side of the road at the picnic and rest area. Outcrops of fairly massive, slightly schistose, nearly vertical beds on the east side of the Molly Stark Trail. These vertically dipping beds strike N.55°E. and consist of garnet-biotite-muscovite-quartz-albite schist alternating with less micaceous, more gneissic beds and thin quartzites. The albite schist encloses buff-weathering calcite lenses and pods 1/4-2 in.

This is one of only two localities in the Hoosac Formation where carbonate lenses or beds have been observed in the Wilmington-Woodford area. If the Hoosac Formation proves to be a facies equivalent of the Readsboro albite schist, these carbonate pods may be the easternmost exposures of albite schists enclosing the Sherman Marble Member of the Readsboro Formation.

Continue east on Route 9.

10.30 Stop 4. CHESTER AMPHIBOLITE

Park on the roadside near Hogback Ski Area. Observe the dominantly easterly-dipping folded beds of the Chester Amphibolite near the Skyline Lodge and Restaurant. The Chester Amphibolite here is characteristically a well-laminated ankerite-bearing epidote-chlorite-hornblende schist with quartz lenses. Note overturned synformal fold plunging to the northeast in which the axial plane dips north. These beds and exposures of the intensely folded Chester Amphibolite and the Stowe Formation, well exposed for the next 3/4 mile on Route 9 east, are near the axis of the Hogback syncline. Figures 20-23 in Skehan (1961) are photos taken at Skyline and Hogback Mountain. On a clear day Shelburne Mountain and the Holyoke Range, Massachusetts may be seen from this stop along with Mount Monadnock and the White Mountains of New Hampshire.

Mileage (cont'd)

Some may wish to walk east along Route 9 approximately 1.1 miles to Stop 5. The drivers and those wishing to ride should proceed east on Route 9, a distance of 1.3 miles.

11.60 At the junction of the road to Adams School, Marlboro, turn right and park along the unpaved road leading south. Walk back along the highway 0.2 mile, and proceed westerly along a logging road to an ankeritic steatite deposit near the boundary of the Stowe and Moretown Formations (Fig. 1).

Return to cars. A trip to alternate Stop 5a can be made by continuing east on Route 9 as follows:

4.75 Boudinaged amphibolite of the Stowe Formation on the north side of the highway.

5.50 Stop 5a. VIEW STOP

Just beyond the crest of a steep hill with large outcrops on either side of the highway, take a sharp right turn into the driveway of the Golden Eagle Motel. Park out of the way in the driveway. The view to the north looks toward Central Mountain on the boundary of the Wilmington and Brattleboro quadrangles, which is underlain by the rocks of the Missisquoi Formation (Fig. 1). This view is shown in Skehan (1961, Fig. 26, p. 89). Proceed westerly on foot along Route 9 for 0.2 mile. The first outcrops on either side of the highway are thin-bedded amphibolites at the top of the Stowe Formation. More ample descriptions of the rocks of the Stowe Formation are given on pages 85-88 of Skehan (1961). Mapping by Osberg (1965) has led to a number of correlations that indicate that the Stowe Formation is probably partially Cambrian and partially Ordovician in age.

Within the Wilmington-Woodford area only two outcrops of unmetamorphosed basalt have been observed, one of which cuts the amphibolites of the Stowe Formation at this locality and may be observed on the south side of Route 9. The other is at Stop 3 of the Sunday Field trip of Skehan (this Guidebook). Outcrops of very coarse-grained, flattened and rotated garnets may be observed on the north side of the road on the Tannelli property. Please do not engage in unrestrained collecting of specimens of these rocks.

Mileage (cont'd)

Return to cars and proceed west, returning to the intersection where cars were parked for Stop 5. Go south 0.55 mile on the road to Adams School at the crossroads. Continue south to Jenckes' Farm.

13.5 Stop 6. PINNEY HOLLOW FORMATION

Turn into Jenckes' Farm and park at the top of the driveway. Proceed south to the artificial pond and begin traverse downstream in the Green River. Excellent exposures of the Pinney Hollow Formation. A mode is presented in Skehan (1961, Table 21, p. 78) for a garnet-chlorite-biotite-muscovite-quartz schist from the Pinney Hollow Formation. Table 30 (p. 133) gives the chemical analysis of the chlorite from this formation. A traverse will be made downstream and up-section through the green schists and minor amphibolites of the Pinney Hollow Formation. The Pinney Hollow at this locality is typical of the Pinney Hollow of the east flank of the Green Mountains. For those making the Sunday Trip with Skehan (this Guidebook) note this rock and compare it with rocks to be seen at Sunday Stop 7.

The Chester Amphibolite is well-exposed in the Green River and here is overlain by the thin sequence of black schists and quartzites of the Ottauquechee Formation and the garnetiferous chlorite-muscovite-quartz schists and minor amphibolites of the Stowe Formation. The Stowe Formation is lithologically indistinguishable in hand specimen or thin section from Pinney Hollow and from the green schists of the Cavendish, except that the latter are commonly more intensely deformed. In certain localities, the Pinney Hollow, the Stowe and the Cavendish carry chloritoid.

Return to cars and continue south along road.

14.60 Junction Green River Road, turn left (east).

14.70 Junction with road to West Halifax, continue straight (east).

14.90 Stop 7. MORETOWN MEMBER, MISSISQUOI FORMATION

Park on the side of road. Outcrops in field to north of road are the Moretown Member of the Missisquoi Formation. Rocks are fairly typical, light gray quartz-mica schists with interlaminations of quartz-rich granulite and mica schist. The scale of the interlamination ranges from 0.5 mm. to several centimeters. Porphyroblasts include garnet, chlorite, and biotite.

Mileage (cont'd)

Return to cars, continue east on Green River Road.

15.30 Entering Brattleboro quadrangle.

15.60 Road junction in Harrisville, continue straight (east) on the Green River Road.

16.00 Stop 8. BARNARD VOLCANIC MEMBER, MISSISQUOI FORMATION

Park cars on the side of road. Small outcrops along the north side of the road are in the Barnard Volcanic Member. These outcrops show some of the variety of the rocks in the Barnard. Hornblende-plagioclase amphibolite, epidote amphibolite, and porphyritic amphibolite with prominent feldspar megacrysts are exposed here. Dark gray to brown weathering chloritic schists and light-colored felsic gneisses and schists are not as abundant here as they are elsewhere in the member.

Continue east on Green River Road.

16.20 Outcrops of Cram Hill Member, Missisquoi Formation.

16.50 Stop 9. CRAM HILL MEMBER, MISSISQUOI FORMATION

Park on the side of the road. This outcrop is typical of the Cram Hill Member, which consists largely of rusty-brown weathering, fine-grained, black phyllite and schist. The rusty weathering is due to finely disseminated pyrite and pyrrhotite. The only porphyroblasts large enough to be seen here are biotite and pyrite. Bedding is difficult to distinguish where thin black quartzite interbeds are not present. A few amphibolites are present in the outcrop. A secondary cleavage cuts the schistosity here, causing the rock to break into elongated tabular blocks used locally as fence posts.

17.50 Crossing Middle Ordovician-Silurian unconformity (not well-exposed along the road).

17.60 Outcrops of Northfield Formation.

18.60 Stop 10. NORTHFIELD FORMATION

Park with care along side of road. The Northfield Formation is a gray quartz-muscovite schist with conspicuous garnet porphyroblasts 1 to 2 mm. in diameter. Biotite porphyroblasts are also common. The dip direction of the principal schistosity is changing in this area from

Mileage (cont'd)

east-dipping off the Green Mountain anticlinorium to west-dipping adjacent to the Guilford dome to the east. A prominent slip-cleavage is present here and is probably related to the rise of the Guilford dome. The slip-cleavage is developed parallel to the axial surfaces of the minor folds of the third stage. The ubiquitous crinkles are the result of the intersection of the schistosity and slip-cleavage surfaces.

19.50 Stop 11. WAITS RIVER FORMATION

Park at the bottom of the hill and walk back uphill to outcrops on the north side of the road. These are fairly typical of the more calcareous portions of the Waits River Formation. The impure marbles weather a punky-brown with a friable surficial rind of the non-carbonate minerals left by the leaching of the carbonates. The fresh marble is steel gray. The modal percentages of carbonates in the impure marble beds range from 35 to 70 percent. Quartz accounts for most of the rest of these beds with minor amounts of muscovite, biotite, garnet, plagioclase and actinolite present. Note the small "skarn" reaction zones at the contact of the marble beds and the surrounding mica schists. The large folds in the marble beds seen here are tentatively correlated with the second stage of minor folding, that congruous with the development of the Prospect Hill recumbent fold.

Return to cars and continue east on Green River Road.

19.60 Guilford-Halifax town line.

20.20 Outcrops of Waits River Formation to north.

20.70 Road junction, turn right (south) toward village of Green River.

21.30 Stop 12. WAITS RIVER, STANDING POND, AND GILE MOUNTAIN FORMATIONS

Park near abandoned farm house. Walk to north end of pasture. From here walk southwest across the pasture through the units in the Prospect Hill recumbent fold. The recumbent fold has been arched by the later doming so that now the units at this locality dip southwest away from the axial trace of the Guilford dome. The exposures in the pasture and along the base of the hill show a nearly continuous section through the Standing

Mileage (cont'd)

Pond and Gile Mountain Formations. At the north end of the pasture, observe the contact of the Waits River Formation with the amphibolites of the Standing Pond. Note garnets to 1/2 inch but please do not remove them. Cross the Standing Pond amphibolites (small ridges) and interbedded brown weathering schists (small gullies). On the second small ridge note the contact of the amphibolite with a schist interbed. Which way is up? The Standing Pond here is some 400 feet thick. The Gile Mountain is exposed along the base of the hill and along the road (see as follows).

The Gile Mountain Formation consists of feldspathic and micaceous quartzites with thin mica schist interbeds. Kyanite and staurolite occur locally in these interbeds. The contact of the Gile Mountain with the Standing Pond at the southwest side of the pasture is placed at the appearance of the first amphibolite. A few thin beds of impure quartzite similar to those in the Gile Mountain occur in the Standing Pond here. Note the development of thin pink bands of coticule (spessartine garnet and quartz) in the Standing Pond near the contact with the Gile Mountain in the woods at the southwest end of the pasture.

Return to road and to cars.

Stop 12a.

Walk south along road 0.1 mile to road cut in the typical interbedded feldspathic and micaceous quartzites and mica schists of the Gile Mountain Formation. The quartzite beds range from a few inches to 3 feet thick.

END OF FIELD TRIP

Return to cars, turn around, head north and proceed to Brattleboro and Burlington.

22.00 Junction with road to Brattleboro, turn right (east).

22.50 Outcrop of Waits River Formation dipping west off the Guilford dome. (Note hill to west--Governors Mountain--formed by the west-dipping Gile Mountain Formation and Standing Pond Volcanics in the Prospect Hill recumbent fold. Slopes on the west side of hill are essentially dip slopes.)

Mileage (cont'd)

23.40 Outcrop of Waits River Formation.

25.60 West-dipping Waits River Formation.

27.10 Junction with unpaved road to left, bear right (stay on paved road).

28.60 Junction Route 9 in West Brattleboro. Turn right (east) and continue approximately 2.5 miles to junction Interstate 91. Take 91 north to I-89 to Burlington. (Note--In the northbound entrance to I-91 from Route 9 there are excellent exposures that include the eastern band of the Standing Pond Volcanics. Here the Standing Pond is a quartz-plagioclase-hornblende-biotite granulite due to the lower, biotite zone, metamorphic grade.)

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